Loads and Dynamics Harmonization Working Group

Disposition of Comments

ANM-98-NE-A

Date: 5/19/00

Document: Notice 99-08 "Revised Landing Gear Shock Absorption Test Requirements"

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General assessment of comments:

There were 6 commenters from aviation manufacturers and foreign airworthiness authorities. Although one commenter objected to the proposed rule, most of the commenters supported the proposed changes. Several of the commenters provided suggestions for clarity, consistency and organization. Because of the substantive nature of some of the comments, the FAA requested the ARAC Loads and Dynamics Working Group by letter dated February 8, 2000 to consider the comments and provide recommendations for the disposition of the comments along with any recommendations for changes to the proposal. Comments are summarized as follows along with recommended disposition text for the final rule.

1) Object to change in basic purpose of the shock absorption tests

One commenter objected to the proposed change in the basic purpose of the shock absorption test from the validation of the load factors to the validation of the dynamic characteristics of the landing gear. The commenter believes that the new proposal has the potential for requiring a significant volume of re-calculation for refinement of load values and this would be neither productive nor cost effective. Furthermore, the commenter believes that this approach would not fit well in the timeline between design concept and the development of the first prototype and so would bring the potential for discovering a different answer for the completed product late in the design process. Finally, the commenter believes the existing regulations are sufficient. The FAA agrees that validation of dynamic characteristics by test always brings a risk if the assumptions made in the prediction of these characteristics are not sufficiently accurate or conservative. However, the process of prediction, design, and validation are normal, and expected, in the development of aircraft and the risks can be minimized by the use of conservative assumptions. Furthermore, the FAA does not agree that the existing shock absorption test requirements are sufficient. The development of airplane loads for dynamic landing conditions requires a valid analytical model of the landing gear which includes a valid representation of the energy absorbing characteristics of the gear. The dynamic landing requirement has existed in CFR 14 for a number of years but the validation shock absorption test requirement has remained outdated, since it requires only the validation of a simple static landing load factor which may not even be used in design of the airplane. Because of the existing dynamic landing requirement, it has become a standard practice

to develop the design loads for the airplane structure based on a mathematical model of the airplane and landing gear and to validate the assumed gear characteristics by shock absorption tests. Therefore, the requirement is being updated to be consistent with the related design landing load requirements and also to be consistent with standard practice.

2) Recommend consistent terminology.

One commenter pointed out that the terminology used in the proposed 25.723(a)(1) for design weight conditions were inconsistent with those used in § 25.473 "Landing load conditions and assumptions", which are the same as those used in the proposed AC 25.723-1. The FAA agrees, and the language in the new paragraph 25.723(a)(1) has been changed to use the same terms "design landing weight" and "design takeoff weight" as currently used in § 25.473.

3) Objects to implication that tests would be required for unsymmetrical landing conditions.

One commenter was concerned that the proposed location of the requirement for shock absorption tests in 25.473(d) implies that the individual tests would be required for each of the landing conditions and configurations specified in § 25.473 including unsymmetrical conditions. The FAA does not agree since the specific landing conditions are referenced in paragraph 25.473(a) while the requirement related to validating landing gear dynamic characteristics, potentially of use in some or all conditions, is set forth in a separate paragraph 25.473(d). Validation is intended to mean that the adequacy of the dynamic characteristics would be confirmed by shock absorption tests to whatever extent necessary to provide confidence in the analysis of the specified landing conditions.

4) Recommend that the specific "dynamic characteristics" be listed in the rule.

The same commenter suggested that the terms, "dynamic characteristics", are ambiguous and that the rule should completely define dynamic characteristics and specify which dynamic characteristics must be validated by tests. The FAA agrees that these terms are general. However, the FAA does not agree that an exhaustive list of dynamic characteristics or shock absorption characteristics can be provided in the rule. The landing gear dynamic characteristics depend on the parameters chosen by the applicant for use in the analysis. The analysis must represent the full energy absorbing characteristics of the landing gear and it would be impossible to provide an exhaustive list of characteristics that would apply to all designs. Typically the manufacturer will validate the dynamic characteristics used in the analysis in a gross fashion by using the analytical mathematical model to predict the shock absorption response time histories in the test for a range of test conditions. In response to this comment, changes have been made to the proposed advisory material to identify some of the energy absorption components and characteristics that are usually of significance and the extent that they could be changed or revised without additional testing.

5) Object to elimination of the reserve energy shock absorption tests 25.723(b).

One commenter was concerned that the elimination of 25.723(b) meant that the reserve energy shock absorption tests would no longer be required. Removal of 25.723(b) was not a proposal of notice 99-08. The commenter failed to recognize that the paragraph is represented in the notice as a set of asterisks at the end of 25.723(a) signifying that that the remaining paragraphs of § 25.723 would remain unchanged. However, consideration of the commenters concern brought to light the fact that the allowance provided in 25.723(a) for using analysis in lieu of tests, would not necessarily apply to the reserve energy drop test of paragraph 25.723(b). In order to correct this oversight, paragraph 25.723(b) is clarified, and the allowance in the proposed paragraph 25.723(a) is now set forth in a separate paragraph 25.723(c) and made applicable to both paragraphs 25.723(a) and (b).

6) Object to eliminating of the reserve energy free drop tests (25.725 and 25.727).

One commenter was concerned that the removal of the free drop test requirements in 25.725 and 25.727 from the rules meant that these tests would no longer be required and that this could result in a reduction in the degree of safety. These specific types of tests, known as free drop tests, have never been required. They have always been a means of compliance to the general requirement to conduct shock absorption tests. This general requirement for conducting shock absorption tests remains in the revised § 25.723. The free drop test criteria are provided for the manufacturer that chooses to use this particular method of performing the required shock absorption tests. In the free drop test, the manufacturer may represent the airplane lift by using a reduced effective weight for the test. However many manufacturers represent the lifting force directly in a drop test or perform other types of shock absorption tests. The criteria for establishing the effective drop weight is applicable to only this one means of compliance and more appropriately presented in an Advisory Circular (AC). To this end AC 25.723-1 "Shock absorption tests" has been made available to provide this means of compliance.

Two commenters were concerned that the removal of the free drop test criteria from the regulation would result in the loss of the current method for establishing the effective mass over the nose gear for the free drop test. As stated above, this information is not being lost but is being moved to an Advisory Circular as acceptable means of compliance.

Conclusions:

Except for the minor editorial and organizational changes mentioned above, the amendment and advisory circular are acceptable as proposed.

Recommended revised proposal:

§ 25.473 Landing load conditions and assumptions.

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(d) The landing gear dynamic characteristics must be validated by tests as defined in § 25.723(a).

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§ 25.723 Shock absorption tests.

(a) The analytical representation of the landing gear dynamic characteristics that is used in determining the landing loads must be validated by shock absorption tests. A range of tests must be conducted to ensure that the analytical representation is valid for the design condtions specified in 25.473~~The landing gear dynamic characteristics used for design must be validated by energy absorption tests. The dynamic characteristics must be valid for all design conditions~~.

(1) The configurations subjected to energy absorption tests at limit design conditions must include at least the design landing weight or the design takeoff weight, whichever produces the greater value of landing impact energy.

(2) The test attitude of the landing gear unit and the application of appropriate drag loads during the test must simulate the airplane landing conditions in a manner consistent with the development of rational or conservative limit loads.

~~(3) In lieu of the tests prescribed in this section, changes in previously approved design weights and minor changes in design may be substantiated by analyses based on previous tests conducted on the same basic landing gear system that has similar energy absorption characteristics.~~

(b) The landing gear may not fail in a test, demonstrating its reserve energy absorption capacity, simulating a descent velocity of 12 f.p.s. in a level attitude at design landing weight, assuming airplane lift not greater than the airplane weight acting during the landing impact.

(c) In lieu of the tests prescribed in this section, changes in previously approved design weights and minor changes in design may be substantiated by analyses based on previous tests conducted on the same basic landing gear system that has similar energy absorption characteristics.

§ 25.725 [Removed and Reserved]

§ 25.727 [Removed and Reserved]

Draft Advisory Circular 25.723-1 (attached)